A Mathematical Model of PD Controller-based DC Motor System using System Identification Approach

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Abstract. A mathematical model is a crucial element of a system. This is to ensure the system obtains outstanding performance, particularly when there is a controller included. Thus, in this study, a comparison between DC motor PD controllers with and without system identification will be made with the concept of poles and zeros. Furthermore, the Cohen-Coon tuning method will be applied to tune the parameters of the proposed controller by using the MATLAB/Simulink software. Then, some tests were performed by varying the number of poles and zeros. After that, the performance of the DC motor with the proposed controller will be assessed in terms of transient response aspects. Throughout the study, it can be guaranteed that the process of system identification is needed to ensure that the performance of the DC motor can be enhanced. With that justification, the performance of the DC motor PD controller with two poles and no zero is better compared to the others. It had the shortest rise time of 0.052s, the shortest settling time of 1.906s, the shortest peak time of 1.142s, and the lowest overshoot of 56.56 percent with no steady-state error.

Keywords: Cohen-Coon Tuning Method, DC Motor System, PD Controller, Poles and Zero, System Identification.

1 Introduction

Generally speaking, an electric motor is a device that uses electricity to create mechanical energy. Alternating current motors (AC motors) and direct current (DC motors) are the two main types of motors [1]. A wide variety of industrial and robotics applications are possible with a DC motor. It can be found in a wide range of control systems, including domestic electrical systems, automobiles, and process control systems [2, 3]. It is widely used due to some reasons which are the maintenance ease to handle, reasonable price when it comes to changing a DC motor with a new one, and simple in terms of speed control [4]. Due to the mentioned benefits that have been provided by the DC motors, they can be used for many things that need variable speed as well as constant or low-speed torque.

Furthermore, a mathematical model of the DC motor system with precise parameters is important for generating an outstanding system response. Because, referring to [2],